business is considered illegitimate as such, but, carried on as it has been, it is incompatible with all the other interests which the forest may subserve. Roaming through the woods, from township to township, from county to county, from State to State, the herds not only destroy the herbage and young trees and seedlings, but the irresponsible herder burns over the pasture, kills the underbrush and young growth that may have sprung up. This treatment, added to the trampling of the soil by the sharp hoofs of the sheep, finally changes the surface so that no seed can germinate, and natural reproduction is prevented and the forest is doomed to destruction. Just as the proverbial incompatibility of the goat and the garden, so the growing of wool and wood on the same gound is incompatible.

Some of the provisions of the bills as passed by the House do not meet the approval of the Executive Committee of the American Forestry Association; nevertheless the main principle underlying, namely, the recognition of the legal status of the forest-reservation policy and of the necessity of their rational management, make it desirable to have this legislation enacted, with the expectation of amending its faulty provisions later.

It is hoped that the 55th Congress will fully recognize the wisdom of upholding the forest reservation policy, and will enact the legislation necessary to make the reservations useful to the fullest extent.

B. F. FERNOW,
Chairman Executive Committee,
American Forestry Association.

EXPERIMENTS UPON METABOLISM IN THE HUMAN BODY, UNDER THE DIRECTION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

THE Department of Agriculture has received and is about to publish the details of the experiments on the nutrition of man, the brief reports of which have lately excited so much interest in different parts of the country. These experiments are carried out under the auspices of the Department of Agriculture, at Wesleyan University, in Connecticut, in cooperation with the Storrs' Experiment Station. They belong to a series of inquiries upon the economy of food and nutrition which are being prosecuted in cooperation with universities, college settlements and benevolent associations in different parts of the country. The special objects and methods of the experiments in Connecticut are referred to by Professor Atwater, special agent of the department in charge of nutrition investigations, as follows:

"Research upon nutrition has brought us to the point where the study of the application of the laws of the conservation of matter and of energy in the living organism are essential. For this purpose a respiration calorimeter is being devised. This is an apparatus in which an animal or a man may be placed for a number of hours or days, and the amounts and composition of the excreta, solid, liquid and gaseous; the amounts and composition of the food and drink and inhaled air; the potential energy of the materials taken into the body and given off from it; the quantity of heat radiated from the body, and the mechanical equivalent of the muscular work done, are all to be measured."

This apparatus includes a so-called respiration chamber. This is practically a box with copper lining. It is 7 feet long, 4 feet wide and 6½ feet high, large enough for a man to live in. It is provided with glass doors, through which the subject enters; and with a chair, table and cot bed. A current of air sufficient for ventilation passes through the box. Arrangements are made for passing in the food and drink and removing the excretory products. The food, drink and excretory products are all carefully weighed, measured and subjected to chemical analysis. The ventilating current of air is measured and analyzed. In this way it is possible to learn just what ma-

terials are taken into the body and what are removed from it. Arrangements are also made for regulating the temperature inside the chamber. In these experiments cold water is passed through tubes in the respiration chamber. These tubes act as absorbers, the heat given off from the body being taken up and carried away by the current of cold water. In this manner the temperature is kept at a point which is comfortable for the occupant at all times. This is the reverse of the system followed in heating houses by means of hot water passed through radiators from which the heat is given off into the rooms. A man can remain in the respiration chamber an indefinite time without particular inconvenience. The experiments thus far made have been of from 2½ to 12 days' duration. The assistant who remained in the chamber during the longest experiment experienced so little inconvenience that he is by no means unwilling to undertake the same task during a period of even longer duration. Observers are at hand day and night. They not only attend to the wants of the subject and supply him with food and drink, but also make the weighings, measurements and analyses needed for the experiment.

THE EXPERIMENTS AND THEIR RESULTS.

These can be best explained by first describing the diet and its nutritive ingredients and then referring to the effects of the food upon the body of the subject. Facts drawn from several of the experiments will be used for this purpose. The first experiment was made with a laboratory janitor. He was a Swede about thirty years old and weighed, without clothing, 148 pounds. He was accustomed to rather active muscular labor, and previous experiments had shown him to be a decidedly 'hearty' eater. He remained two and one-fourth days in the apparatus. He drank water *ad libitum*. His daily food was as follows:

	Ounces.
Cooked meat	4.3
Eggs	3.5
Potatoes	5.3
Bread	8.8
Milk crackers	3.5
Butter	1.1
Cheese	2.7
Milk	35.1
Sugar	0.8
Coffee	10.5
Total	75.6

During the experiment the subject did no work; he read a little, but had extremely little muscular exercise. The diet was necessarily simple because of the labor required for the preparation, measurement and analysis of the foods. It was, however, entirely agreeable to the subject and the quantities were such as he chose. In estimating the quantities of nutritive ingredients of the food it is customary to take into account the protein, fats and carbohydrates and the potential energy or fuel value. The protein compounds which occur, for example, in the lean of meat, white of egg, casein of milk, gluten of wheat, are the so-called tissue-forming substances. They make blood and muscle, bone and brain. The fats include the fat of meat, the fat of butter and milk, the oil of wheat, etc. The carbohydrates are the sugars and starches, such as the starch of bread and potatoes and ordinary sugar. The fuel values are estimated in heat units or calories. The fats and carbohydrates are the chief fuel ingredients of the body, although the protein compounds serve to some extent as fuel. But while the protein compounds can do the work of the fats and carbohydrates in supplying fuel for warmth for the body and for its muscular work, neither fats nor carbohydrates can take the place of the protein in building and repairing the tissues of the body. In considering the nutritive in-

gredients of the food, therefore, we have to take into account the amounts of protein and the fuel values. The daily diet used in this experiment was found to furnish, in digestible form, 4.8 ounces of protein and 2,960 calories of energy. It may be added that coffee, like tea, contains practically no nutrients, except those of the milk and sugar used with it.

Taking into account the food and excreta it is possible to calculate how much protein or fat the body gained or lost per day during the experiment. In the experiment with the diet referred to, the man's body gained about half an ounce of protein and two and one-tenth ounces of fat per day. This shows that the diet was more abundant than was required for the maintenance of his body. In other words, he was supplied with more protein and fuel ingredients than he required. This was not surprising, since during the period of the experiment he performed practically no muscular work, while his diet had been selected in accordance with his ordinary eating habits when he was engaged in his daily labor.

In a second experiment with the same man the diet was reduced, mainly by diminishing the amount of milk from about one quart to one pint per day. The protein was thus reduced to 3.9 ounces and the fuel value of the digested nutrients to 2,650 calories. With this diet the body almost exactly held its own as regards protein, but still gained a small quantity of fat, about half an ounce per day, showing that the food still exceeded the amount needed to supply the wants of the man's body when he was practically at rest. It was calculated that if the amounts of milk, potatoes and butter in his diet had been reduced by one-half the nutrients would have just sufficed to meet his needs under the conditions of the experiment.

In another experiment, which is the most interesting of all, the subject was a young man 23 years of age, rather taller than the laboratory janitor, quite muscular, and weighing 168 pounds without clothing. He had been accustomed for a number of years to school and college life, and later, to the work of an assistant in the college laboratory. This occupation involved but little muscular activity. Previous experiments had shown that he was inclined to eat rather small quantities of food. His daily diet during the experiment was of his own choosing as in the former case. The food materials were as follows:

	Ounces.
Cooked beef	3.4
Mashed potatoes	3.5
White bread	5.4
Brown bread	8.8
Oat meal	1.5
Beans	4.3
Butter	1.6
Milk	22.9
Sugar	0.6
Apples	4.3
Total	56.3

The experiment showed that he digested from this food on the average about 3.3 ounces of protein and with it enough fats and carbohydrates to make the fuel value of the digested food 2,500 calories per day.

The experiment was divided into five periods. During the first period (1⅓ days) and the fifth (1⅔ days) the subject was at rest. He passed more or less of the time in reading, but did nothing to require any considerable exercise of either muscle or brain. The second, third and fourth periods were of 3 days each. During the second period he engaged in severe mental work, partly in calculating the results of experiments and partly in studying a German treatise on physics. The third period was one of absolute rest. The subject sat in his chair or reclined upon the cot bed, but did no reading and moved about as little as possible. In the fourth period he per-

formed severe muscular exercise. During eight hours of each of the 3 days he was engaged in raising and lowering a heavy weight which was suspended by a cord passing over a pulley at the top of the chamber. The work in this case was so severe that he was thoroughly exhausted.

The result showed that the subject during the periods of rest gained about half an ounce of protein and lost not far from the same quantity of fat daily. The diet which was roughly calculated in advance to be very nearly sufficient for the needs of the organism when no considerable amount of work was done proved to have a slight excess of protein and not quite enough fats and carbohydrates. With the severe mental work the results were almost exactly the same. During the 3 days of hard study the organism consumed about the same quantities of nutrients as when it was at rest. Whether this would prove true for a longer period is not certain.

During the period of hard muscular work the results were quite different. As was to be expected, the food did not suffice for the demands of the body. Instead of gaining one-half an ounce, the organism lost about one-sixth of an ounce of protein per day, while the loss of fat reached 6.9 ounces. The fuel value of the materials consumed in the body during the periods of rest and of mental work ranged from 2,600 to 2,700 calories per day, but in the period of muscular work it rose to 4,325 calories. In this case, therefore, the severe muscular work increased the consumption of protein by over half an ounce and the consumption of fats by more than seven ounces per day. The experimenters have estimated the changes which would have been needed in the daily food to make it equal to the demands of the body during the period of muscular work. They calculate, for instance, that if the daily food had been increased by doubling the butter and sugar and adding half a pound of bacon it would have been sufficient.

The chief interest of these experiments, from the practical standpoint is the light they throw upon the ways the food is used in the body and the kinds and amounts that are appropriate for people of different occupations and under different circumstances. Physicians tell us that disease is largely due to errors in diet. It is only by such researches that the exact knowledge can be acquired which is needed to show how our diet can be fitted to the demands of health and strength as well as purse. In addition, the experiments have great scientific interest.

A number of experiments of this kind have been made in Europe, but these are the first in the United States. These investigations are being continued by the Department of Agriculture, and further reports may be expected from time to time.

Thus far we have described only those features of these investigations which included the measurement of the income and outgo of matter and the determination of the fuel value of the food. The fuel value of excretory products was also determined, as well as the energy manifested by the body in the form of heat or external muscular work. For the measurement of the body's energy delicate and elaborate apparatus was devised. Highly interesting results have already been obtained, but so many improvements in the methods and apparatus have suggested themselves during the progress of the work that it has not been deemed advisable to publish the details of this part of the investigation at present.

AN INDUCTION-COIL METHOD FOR X-RAYS.

SINCE sending a note of a new method of operating an induction coil by the discharge of a condenser we have used it for operating X-ray tubes, and find it gives us a